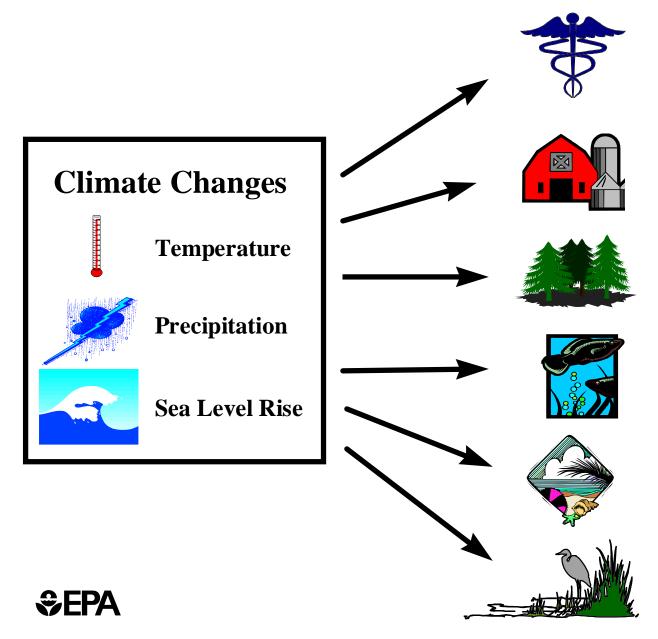
## Climate Change Impacts

- Human health, natural ecological systems, and socioeconomic systems are all sensitive to both the magnitude and the rate of climate change
- Many physical and ecological systems will be simultaneously affected
- The ability of natural ecological systems to migrate appears to be much slower than the predicted rate of climate change
- "With the growth in atmospheric concentrations of greenhouse gases, interference with the climate system will grow in magnitude, and the likelihood of adverse impacts from climate change that could be judged dangerous will become greater" (IPCC, 1995)
- Climate change can add to existing environmental stresses

## **Potential Climate Change Impacts**



#### **Health Impacts**

Weather-related Mortality Infectious Diseases Air Quality-Respiratory Illnesses

#### **Agriculture Impacts**

Crop yields Irrigation demands

#### **Forest Impacts**

Change in forest composition Shift geographic range of forests Forest Health and Productivity

#### **Water Resource Impacts**

Changes in water supply Water quality Increased Competition for water

#### **Impacts on Coastal Areas**

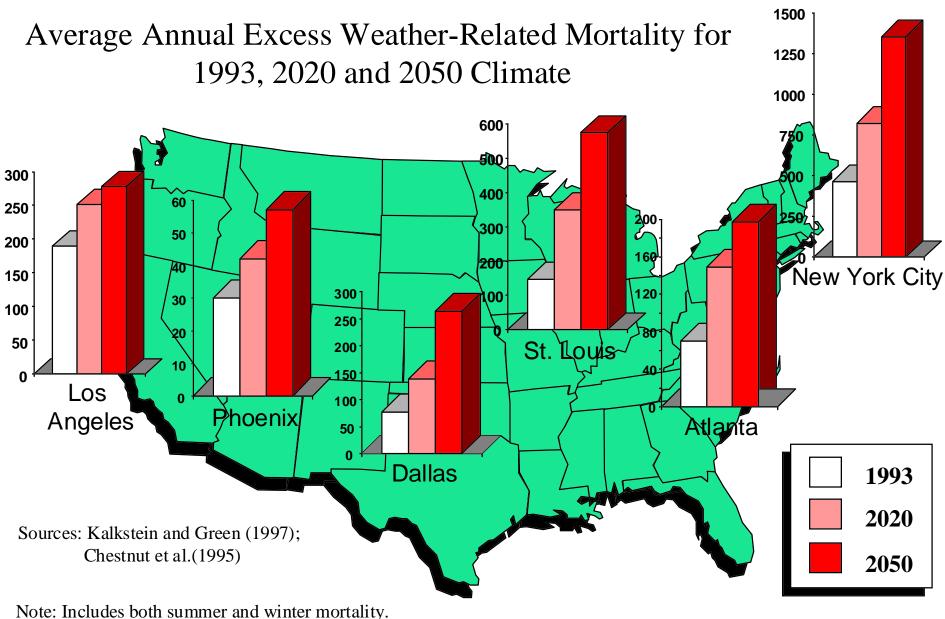
Erosion of beaches Inundate coastal lands Costs to defend coastal communities

#### **Species and Natural Areas**

Shift in ecological zones Loss of habitat and species

## Direct weather-related mortality

- Climate change is expected to increase the frequency of very hot days
  - For Chicago, if average July temperatures rise 5.4°F,
     the probability the heat index will exceed 120°F during
     the month increases from one in 20 to one in 4
- During heat waves, deaths from cardiovascular and respiratory illnesses also increase
- Winter mortality may decrease, but not expected to offset summer mortality increases
- The elderly, particularly those living alone, and children are in the greatest danger during heat waves



Note: Includes both summer and winter mortality.

Assumes full acclimation to changed climate.

Includes population growth.

GFDL Climate Change Scenario



### Water Resources

- Precipitation changes and increased evaporation can affect:
  - water supplies
  - water quality and drinking water
  - water uses: hydropower, irrigation, fisheries
- Floods more likely due to more intense rainfall
- Droughts likely to be more severe due to increased evaporation and drier soils
- Climate change will add to stresses in the Great Basin,
   California, Missouri, Arkansas, Texas Gulf, Rio Grande and Lower Colorado river basins

## Examples of Regional Water Impacts

#### San Francisco Bay:

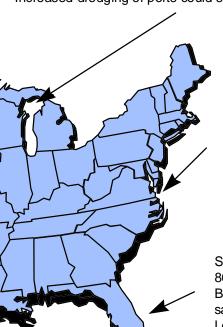
Sea level rise of 15 in. by 2100 Delta islands and marshes at increased risk of inundation Increased salinity in the bay and inland migration of saltwater

#### Colorado River Basin:

Runoff likely to decrease, exacerbating salinity problems Shift in seasonality of runoff, with increased potential for winter and spring flooding. Water deliveries may be dramatically affected

#### **Great Lakes:**

Ave. lake levels could fall by 1.7-8.3 feet Higher water temps could change thermal structure Increased dredging of ports could suspend toxic sediments



#### Chesapeake Bay:

Sea level likely to rise 2 feet by 2100. Most existing wetlands inundated. Currently building 20 miles of bulkheads per year in Maryland, preventing new wetlands from forming. Smith Island and Blackwater Refuge likely to be drowned

#### Florida:

Sea level rise of 20 in. by 2100. 800 sq mi of wetlands at risk Biscayne aquifer could become salty with 3 foot rise in sea level Loss of shrimp, crabs, oysters, and other species

## Pressure for more irrigation

**Great Plains:** 

Surface runoff and erosion of agricultural pesticides may increase Less leaching of pesticides likely, lowering risks to groundwater quality, but may have less water available for aquifer recharge

#### Louisiana:

Sea level rise of over 4 feet by 2100 4,000 sq mi of wetlands at risk Increased vulnerability of coastal drainage and sewage systems Cumulative cost estimates of fortifying barrier islands range from \$2.6 to \$5.4 billion

Source: EPA, 1989; EPA, 1995

California:

spring and summer runoff and streamflow

Decrease in water supply and reliability

Increased winter runoff, reduced

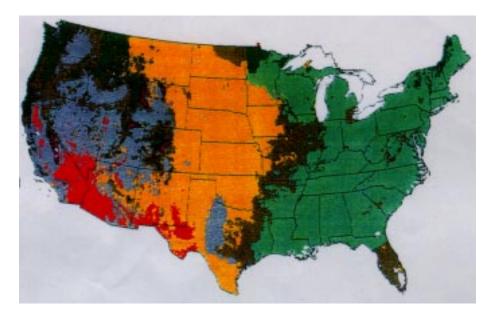
in Central Valley Basin.



## Impacts on Forests

- Suitable habitats for many tree species likely to shift faster than rate at which trees naturally migrate
- Forest dieback due to drought, insects and disease may increase, especially along southern boundaries and in drier areas
- Projected increase in summer droughts would increase risk of forest fires, especially where forests are already under stress
- At risk are commercial timber production, recreational activities, and wildlife habitat

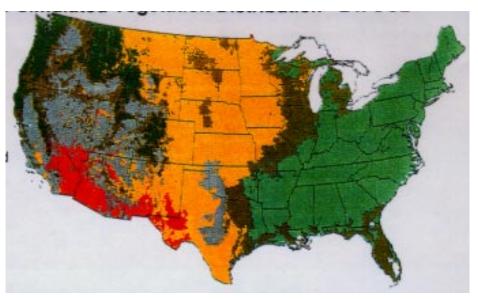
# Change in Potential Vegetation for 2050 Climate Scenario



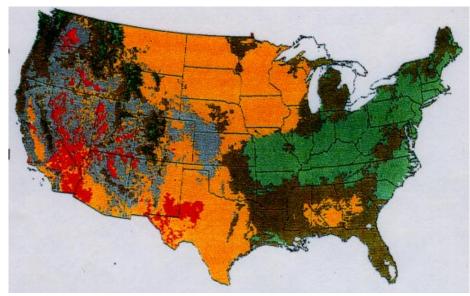
**Current Climate** 

Conifer Forest Broadleaf Forest Savanna/Woodland Shrub/Woodland Grassland Arid Lands

Source: Neilson, 1995



**OSU Climate** 

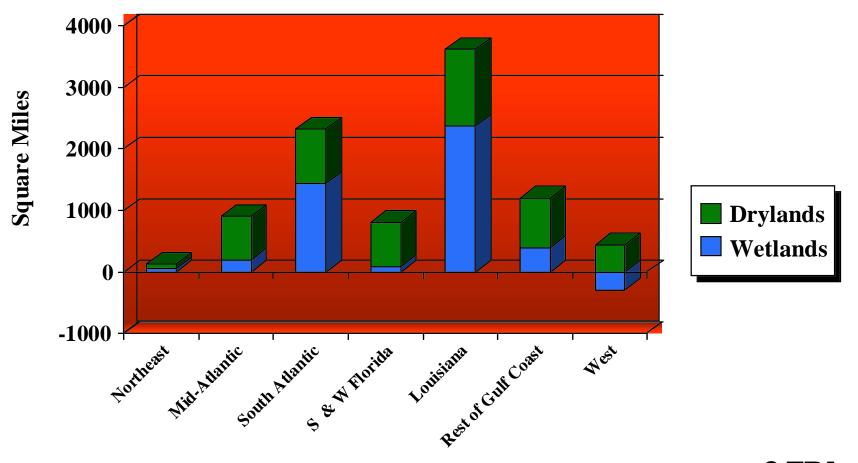


**UKMO Climate** 

## Impacts on Coastal Areas

- Along much of the U.S. coast, sea levels have risen 10-12 inches in the last century
- Sandy beaches would be eroded 100-150 feet with a 1-foot rise in sea level in 2100
- The projected global sea level rise of 20 inches (6-38 inches) by 2100 could:
  - Inundate 5,000 square miles of dryland
  - Drown 15-60 percent of our coastal wetlands
- Some states will experience greater increases in sea level (e.g., over 4 feet in Louisiana)
- Cumulative capital costs of defending against a 20 inch rise in sea level are estimated at \$30-40 billion (1988 \$)

## U.S. Coastal Lands at Risk from a 20-inch Sea Level Rise in 2100



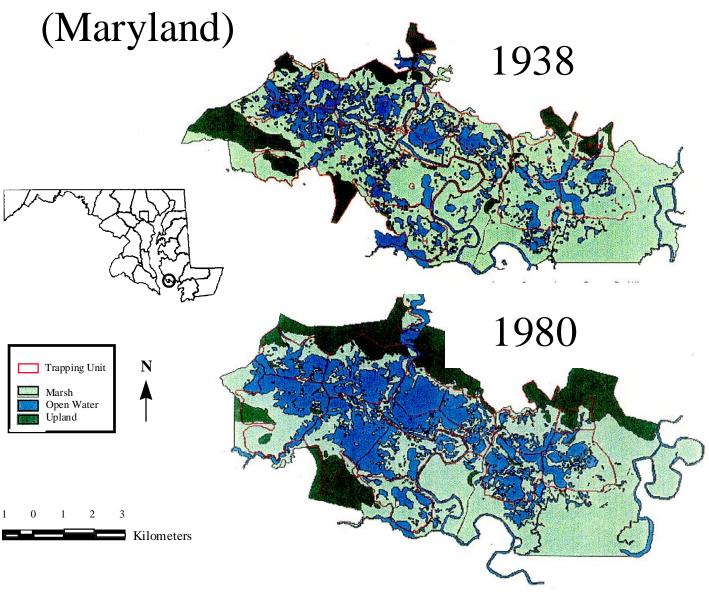
Source: U.S. EPA (1989).



## Impacts on Wetlands

- Coastal wetlands are vulnerable to sea level rise and coastal erosion
  - At risk: fish, shellfish, flood and erosion control, habitat
- Inland freshwater marshes (including prairie potholes) are vulnerable to hotter, drier conditions
  - At risk: migratory bird and other species habitat
- Western riparian wetlands are vulnerable to hotter, drier conditions
  - At risk: fish and wildlife habitat, flood and erosion control, water quality, grazing

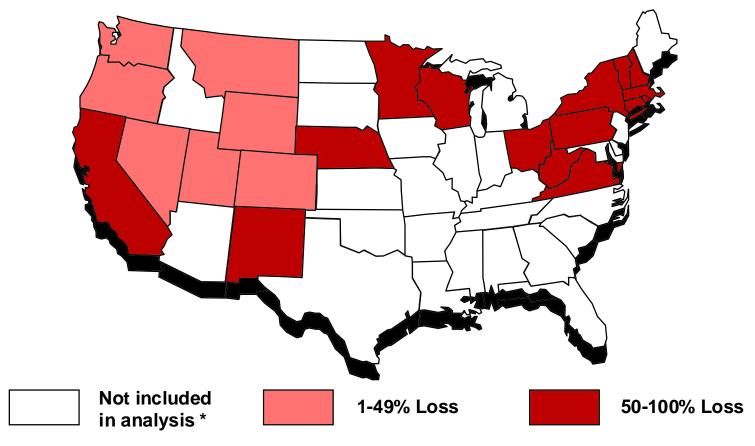
## Blackwater National Wildlife Refuge



## Impacts on Species

- Each 1°C of warming will shift temperature zones by about 100 miles northward (or 500 feet in elevation)
  - Many plant and animal species will be unable to migrate fast enough to find suitable habitats
  - Natural or man-made barriers may block natural migration
- Climate change poses risks to major U.S. national parks (e.g., Everglades National Park, Glacier National Park)
- An increase of 3°C could threaten 7-11% of North America's plant species
- Northern limits of many birds strongly associated with climate
- Loss of cold-water fish habitat of 1.7-2.3 million acres by 2060

## Loss of Habitat for Brown Trout from a Doubling of CO<sub>2</sub> - 2050



\* Dual screening criteria used for inclusion: 1) Thermal modeling predicts suitability and 2) Fish presence in 10% or more of State's water bodies.

Source: EPA, 1995 GFDL Climate Change Scenario

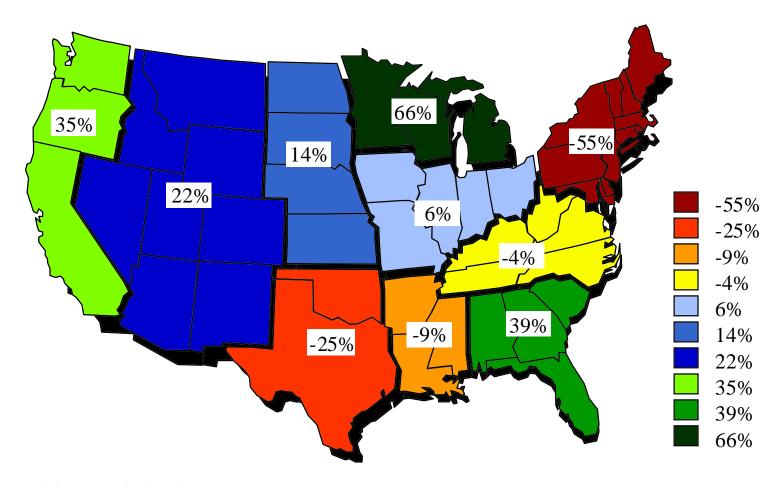


## Agriculture

- Current modeling is inadequate because it fails to fully account for climate variability, adaptation, and indirect effects
  - Place specific modeling needed since temperature, precipitation, and soil moisture changes and water availability varies from place to place
- Average climatic changes projected to affect crop yields and the geographic distribution of crops
  - Some states will gain, but other states may see substantial losses
  - Some crops will be more impacted than other crops
- Farmers likely to adapt to changing climate conditions
  - Some agricultural adaptations may be costly
  - Adaptation may alter land-use patterns (e.g., forests converted into agricultural land)
  - Adaptation often depends on questionable availability of water

### Change in Regional Crop Production - 2060

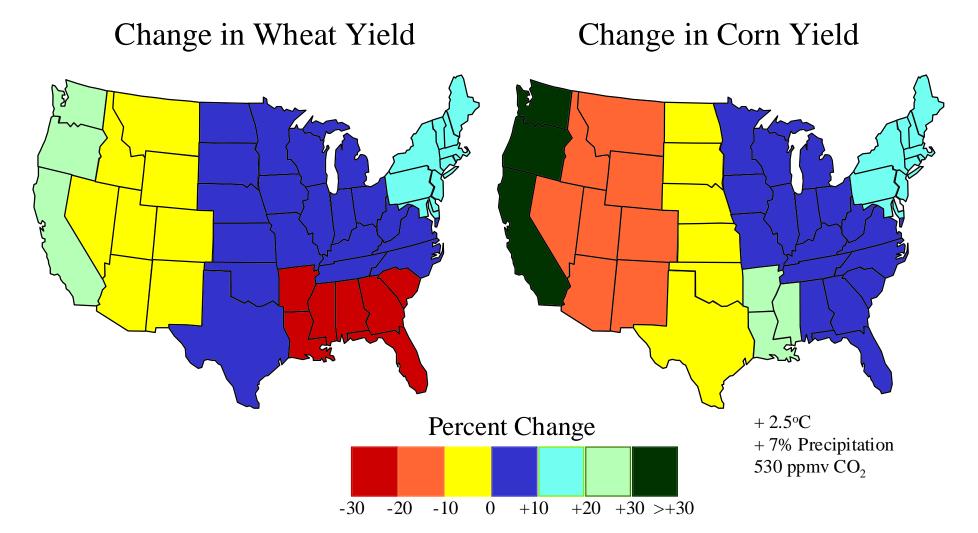
5°F Warming; 7% Increase in Precipitation; 530 ppmv CO<sub>2</sub>



Source: Adams, et al. (1996)



## Changes in Agricultural Yields



Source: Rosenzweig, 1995

